

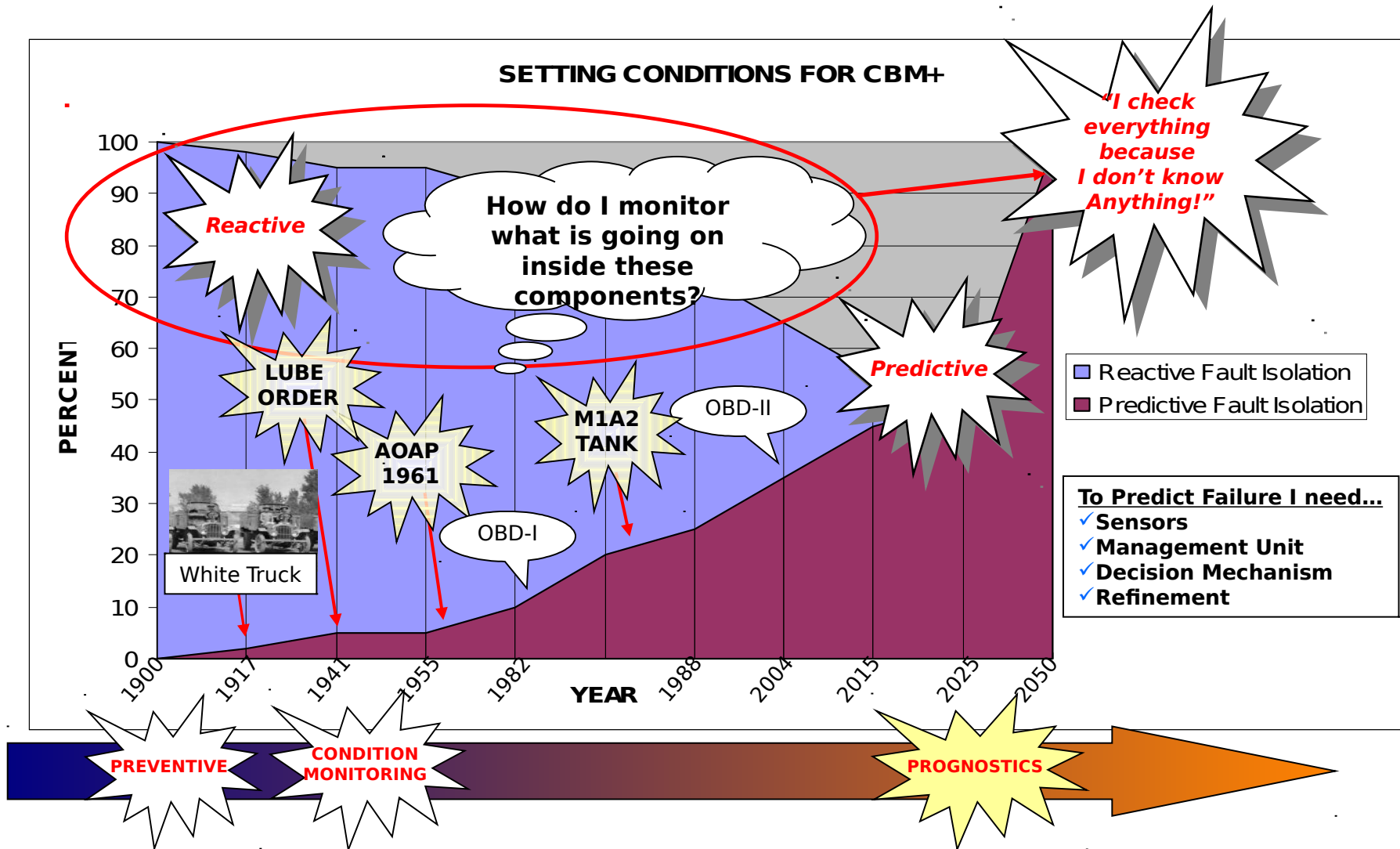


Equipping the American Forces with a Reliable and Robust Condition Based Maintenance Plus Capability

Colonel Sarah J. Smith, USAF
Military Deputy to ADUSD
Materiel Readiness & Maintenance
Policy



CBM+ Origin





Overview

The need for effective policy and doctrine to underpin the emerging capabilities of integrated mechanical diagnostics/ prognostics and advanced maintenance systems

- Optimizing platform readiness, safety and reliability to ensure maximum capability
- The challenges in creating and implementing policy for new and emerging maintenance technologies and systems
- The US DoD requirements for effective maintenance systems
- The impact of HUMS/future maintenance systems within the operational and logistical command chains
- The effects on future logistic and maintenance based policy and doctrine



Condition Based Maintenance Plus

Why?

- Decrease maintenance burden on the warfighter
- Increase platform availability and readiness
- Reduce Operations & Sustainment costs

What?

- Maintenance capabilities:
 - Enhancing diagnostics...
 - Evolving to predicting remaining component life...
 - Then to proactive supply transactions
- Derived from near real-time assessment and analysis of data from:
 - Embedded sensors
 - Platform maintenance environments
 - Weapon system and supply historical data

How?

- Interactive electronic technical manuals, portable maintenance aids, other enabling tools and technologies
- Diagnostics, sensors and prognostic algorithms & techniques
- Reliability-centered maintenance concepts and practices
- Statistical and engineering analysis processes
- Condition-driven maintenance plans
- Integrated maintenance and logistics processes & reporting systems



“Note that without prognostics, the CBM+ initiative looks a whole lot like RCM.” *USAF Aircraft Maintenance Officer*



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Current CBM+ System



"The best current CBM+ system is a well-trained, well equipped, very experienced maintenance technician who has the time and inclination to correspond in meaningful terms with the AFETS and Engineering people. Don't take that wrong. What I mean is that the closest thing we have to a system that can predict when a system will fail is the dedicated, expert technician." *USAF Aircraft Maintenance Officer*



Air Force Initiative: Instrumentation of Critical Life Areas in Aircraft

- One of the lessons we learned,...is that we do not have sufficient reliability and structural integrity information to determine the correct course of action relative to the future of our aging fleet.
 - ...the uncertainty in reliability and structural integrity in that fleet
- We have the means and methods for achieving a data driven analysis across our fleet.
 - We have extraordinary fleet reliability experts..., extraordinary data analyzers....the Fleet Viability Board....
- What is needed now is to provide [them]...the right information....





Overview

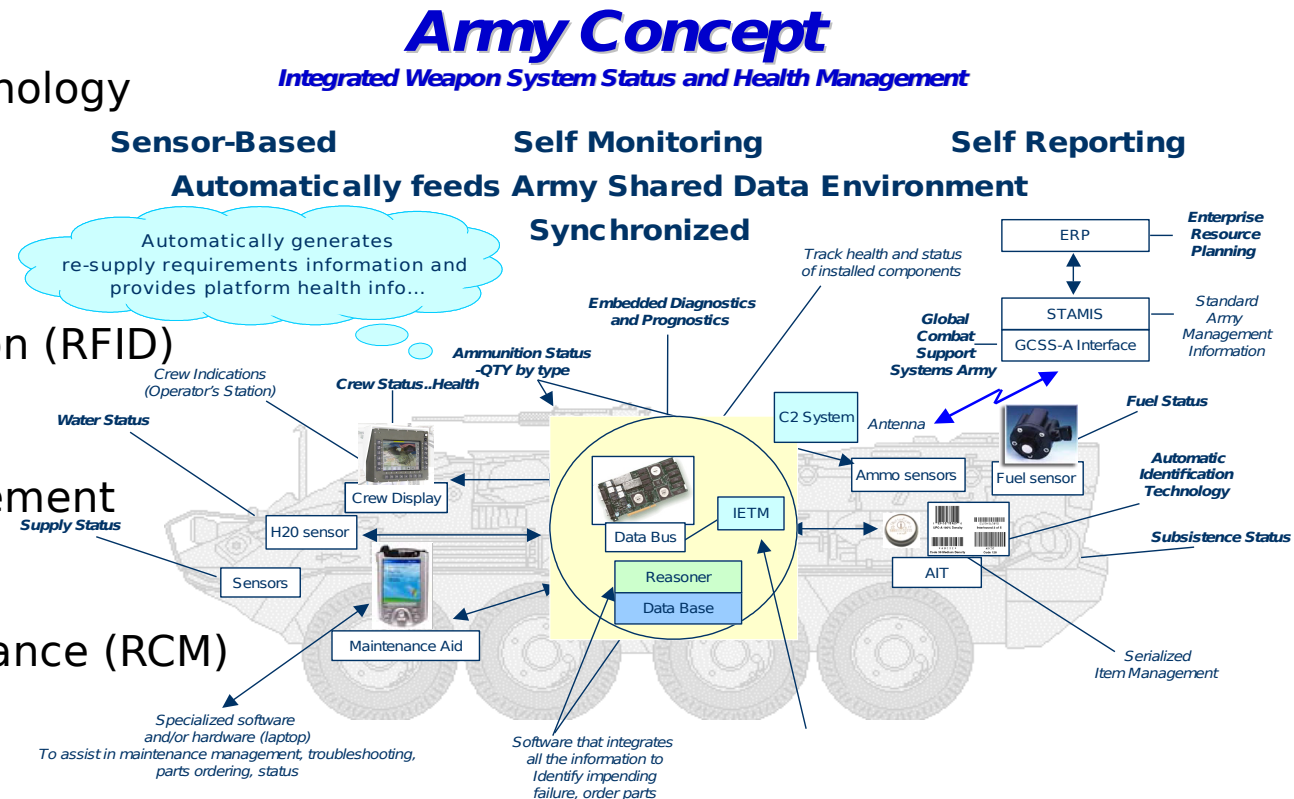
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CBM+ Elements and Enablers

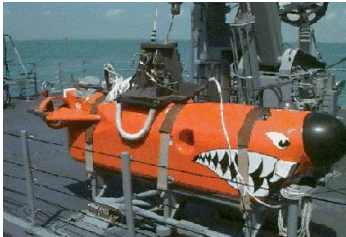
- Sensors and algorithms
- Condition status reporting
- Data collection techniques
- Automated Information Technology
- Serialized Item Management
- Troubleshooting
- Unique Identification
- Diagnostics
- Prognostics
- Radio Frequency Identification (RFID)
- Prognostics
- Fault Isolation
- Health monitoring & management
- Systems integration
- Interactive training
- Reliability Centered Maintenance (RCM)
- Analog condition extenders
- Built In Test (BIT)
- Asset visibility
- Integrated information tools & systems
- Portable maintenance aids (PMA)
- Interactive electronic technical manuals
- [Systems & Sustaining] Engineering analysis



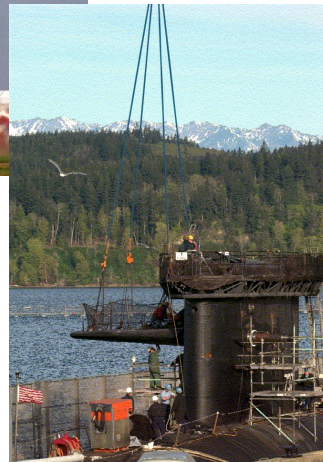


Legacy and Aging Weapon Systems

- Can CBM+ be implemented on legacy and aging weapon systems, and...



is it cost-effective to do so?





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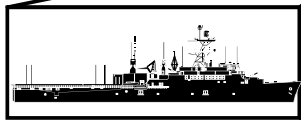


Weapon Systems Supported by DoD Maintenance

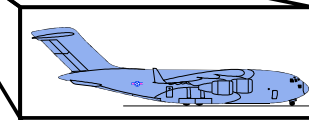
100,000+
Ground Combat/
Tactical Vehicles



~ 900
Strategic Missiles



~ 280 Ships



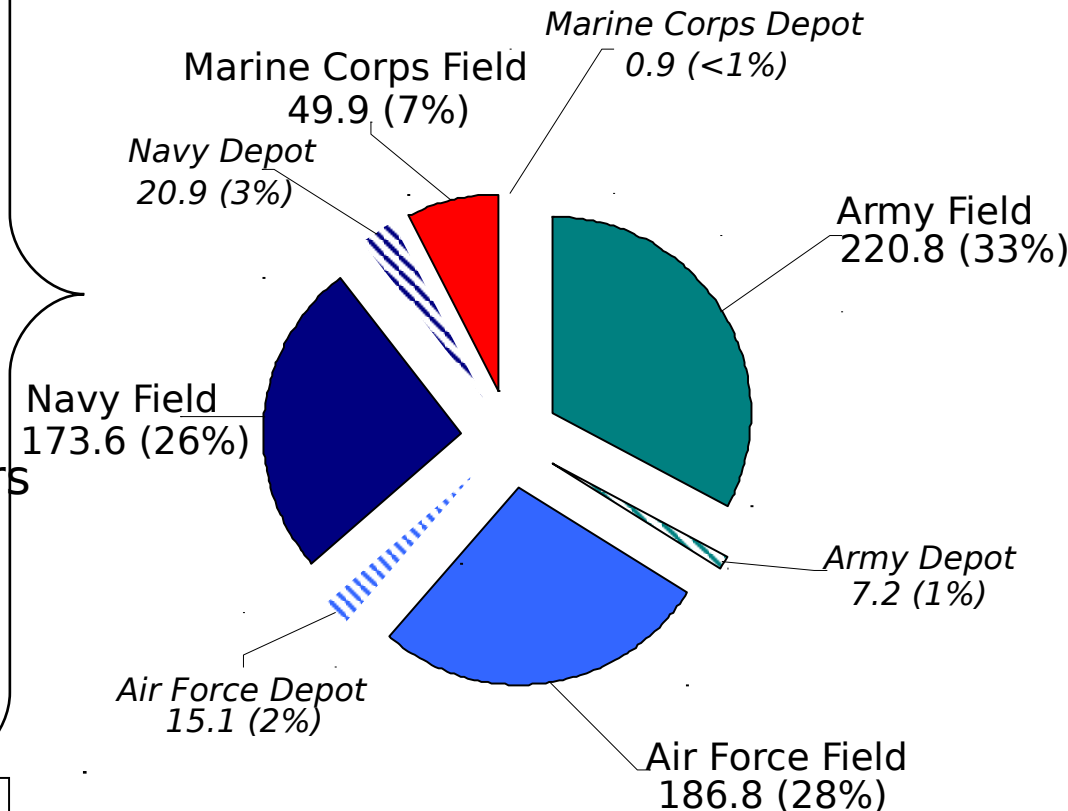
~14,000
Aircraft/Helicopters

+ 250K+ Wheeled Vehicles
+ Comm/Electronics Equipment
+ Support Equipment
+ ...

National Defense PP&E is valued at
~ \$700 Billion

Maintained by:

- 678,000 DoD personnel
- Private sector companies



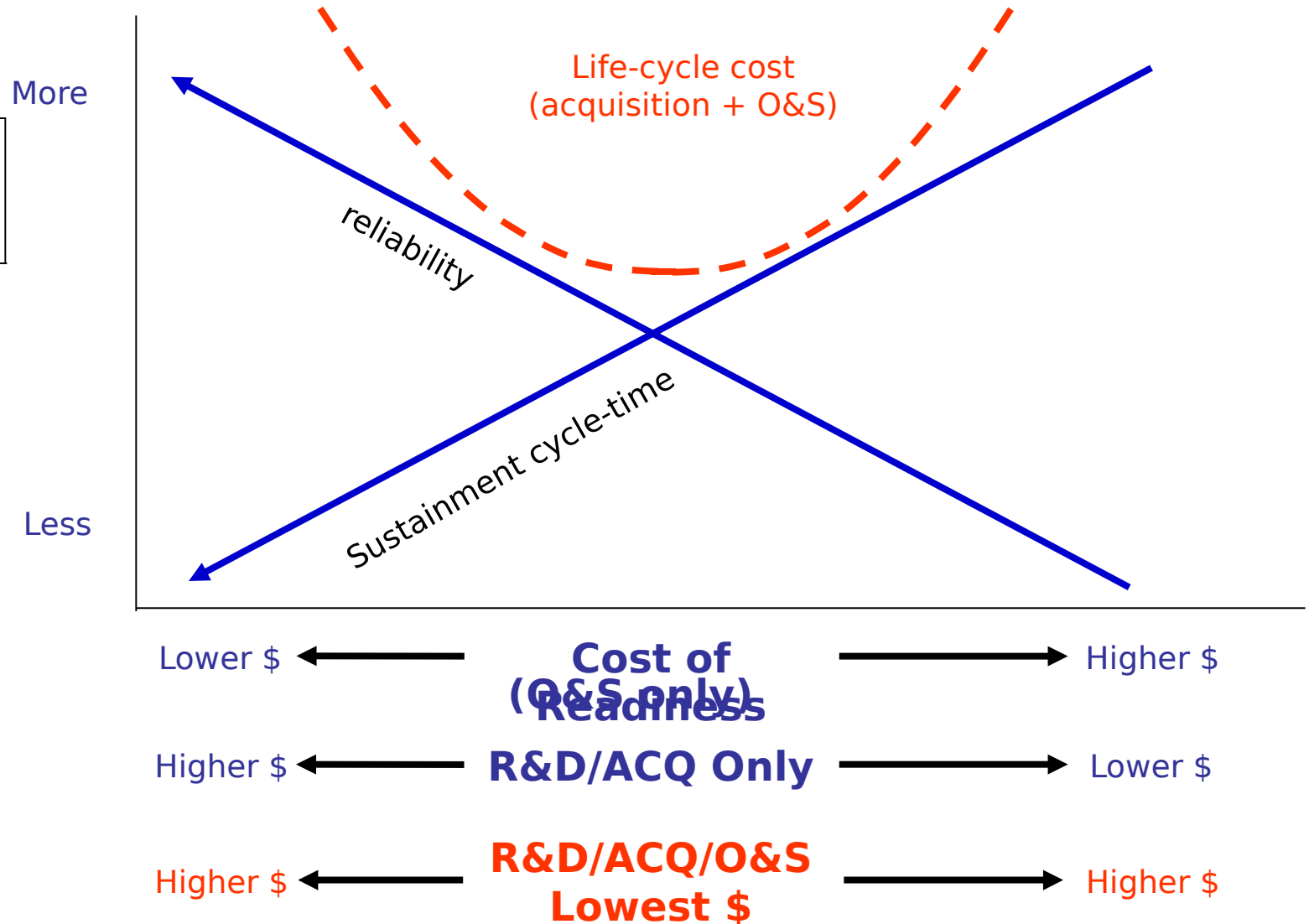
Maintenance cost: ~\$63B per year



Improving Materiel Readiness: Reliability, Cycle-Time, Cost

**Drive reliability
up to
optimum level**

**Drive
sustainment
cycle time
down to
optimum level**





Sustained Materiel Readiness

ISSUE:

- **Concentrate on achieving and sustaining SPG/CPG readiness**
 - Balance safety, reliability, and maintenance activities to achieve readiness at best cost.
 - Optimize TIME-ON-WEAPON SYSTEM and repair TURN AROUND TIME
- **Promote End-to-End (E2E) materiel readiness value chain perspective across DoD**
- **Optimize materiel condition reliability sustainment**
- **Optimize maintenance cost, cycle time**

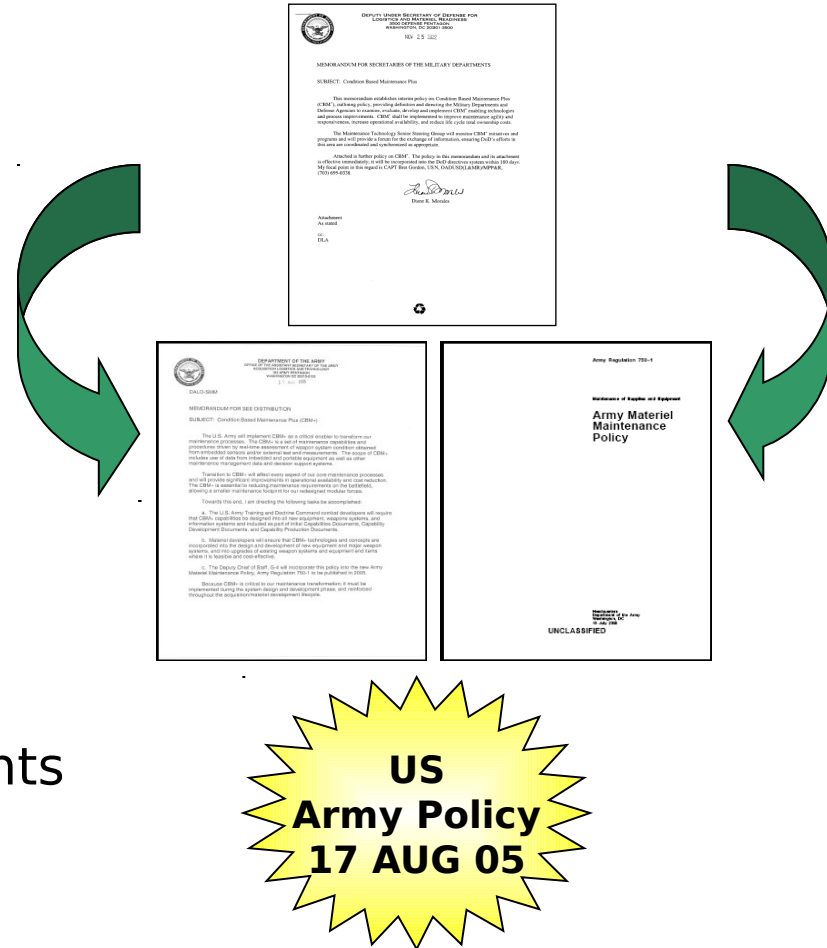
WAY AHEAD:

- **Translate SPG/CPG capabilities to weapon system/materiel requirements**
- **Foster and promote Continuous Process Improvements (CPI)**
 - **Reliability**
 - Condition Based Maintenance Plus (CBM+)/Reliability Centered Maintenance (RCM)
 - **Cycle process discipline**
 - Lean, Six Sigma, Theory of Constraints, etc
- **Develop cause and effect predictive models**
- **Institute integrated budgets (engineering, logistics, industrial)**



CBM+ Policy

- CBM+ key policy tenets...
 - Need-driven, reliability centered maintenance
 - Embedded diagnostics and prognostics
 - Automated maintenance information generation
 - Trend-based reliability and sustainability process improvements
 - Integrated information systems providing logistics response based equipment condition and tasking
 - Smaller maintenance and support footprints
 - Improved Operational availability





CBM+ Select Programs

– Army

- Future Combat System (FCS)
- Apache
- Stryker

– Navy

- Maintenance Effective Reviews (MER)
- Engineering for Reduced Maintenance (ERM)
- Integrated Condition Assessment System (ICAS)
- Smart Ship

– Air Force

- C-17
- JSF

– Marine Corps

- Expeditionary Fighting Vehicle (formerly AAV)
- Light Armored Vehicle (LAV)

– Defense Logistics Agency

- Service Parts Ordering Tool (SPOT) – AWACS
- DLA Reliability Initiative



CBM+ Implementation Phases

IOC 2011

FOC 2015

FY 05-07

FY 08-15

FY 16+

Phase 1 - Concept

Development

- Proof of Principle
- Develop Data Warehouse
- Develop Prognostics
- Assess Impacts to DOTMLPF
- Assure Interoperability With:
 - GCSS-A
 - CLOE
 - LMP

Phase 2 -

Implementation

- CAB Pilot Fielding
- Continuous Data Analysis
- Refinement of Prognostics
- Changes to DOTMLPF
- Examine New Technologies

Phase 3 - Operations

- Sustain CBM+
- Continuous Data Analysis
- Refine Prognostics
- DOTMLPF Improvements



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CBM+ Program Focus: Benefits for Warfighters

To Battlefield Commanders, CBM+ Is:

- Ability to Meet Mission Requirements With Proactively Driven Maintenance
- Ability to Optimize Competing Demands of Warfighting & Planned Maintenance



To The Warfighter, CBM+ Is:

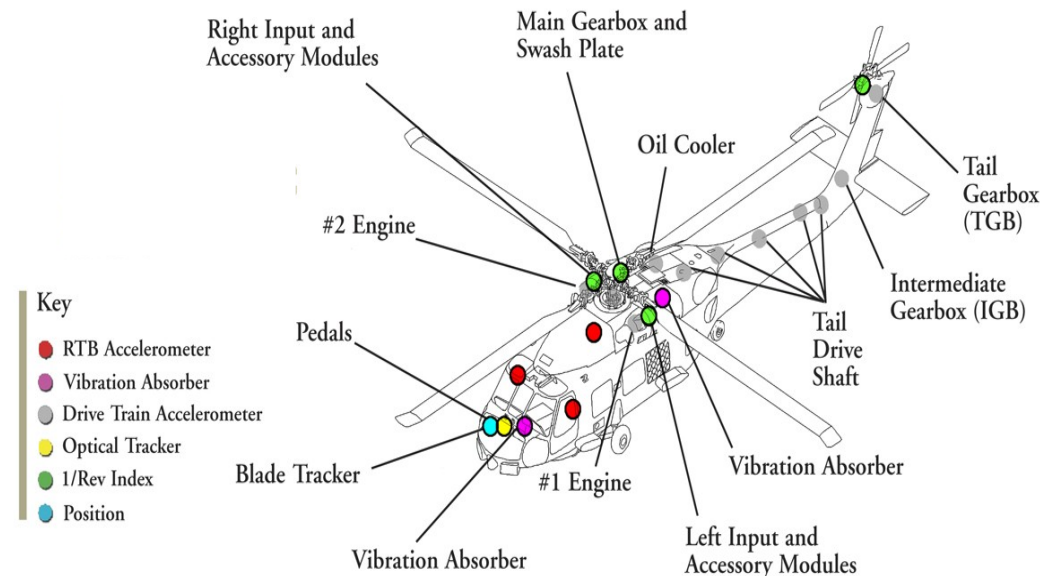
- Maintenance Instructions Based on Actual Condition and Usage
- Greatly Enhanced Diagnostics and Troubleshooting
- Fewer Maintenance Manhours
- Physical Inspections Are Reduced or Eliminated





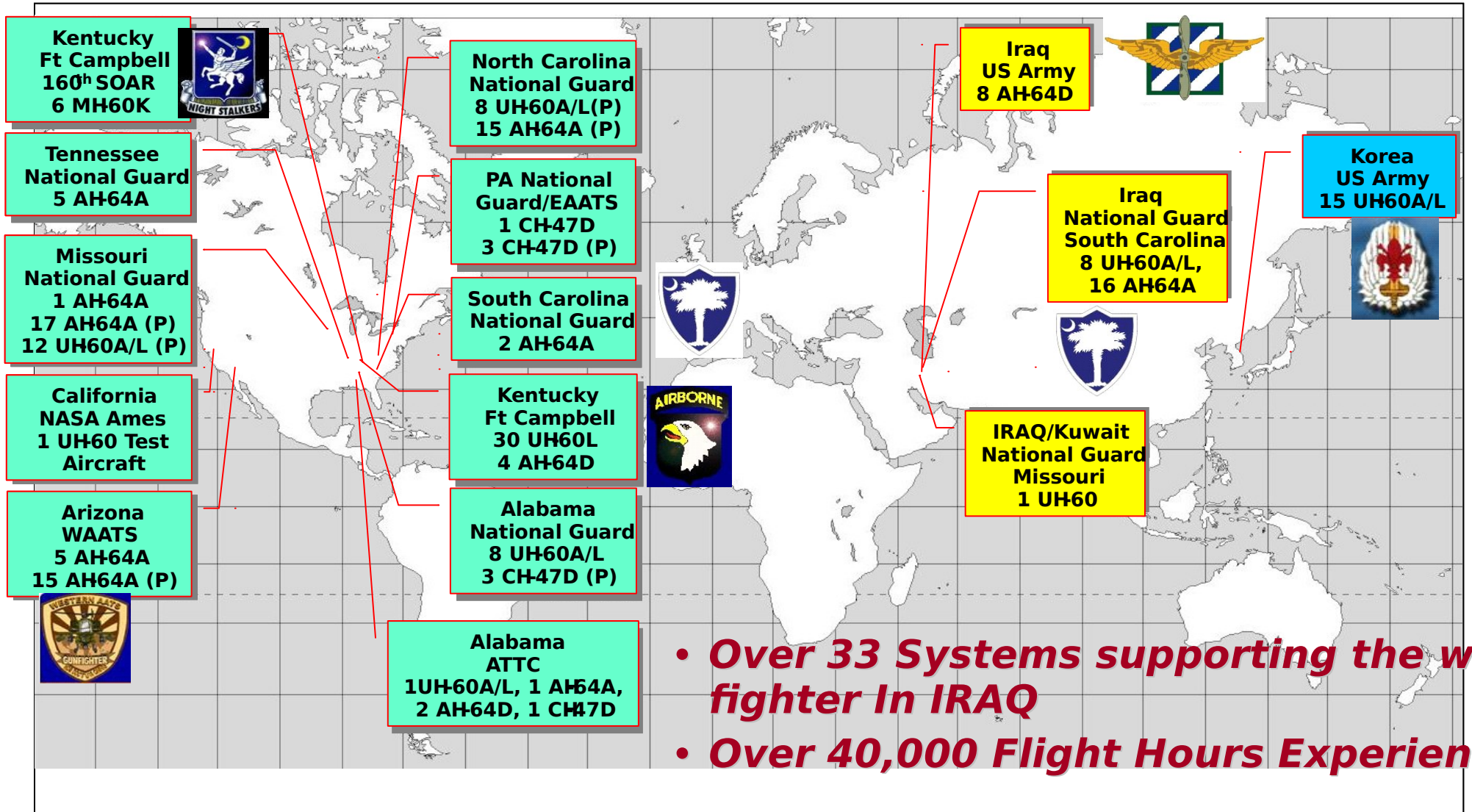
Potential Benefits to Warfighters

- AH-64 Block III Fleet
 - 10 Parts
 - Readiness +4.9%
 - **Maintenance Burden reduced by 41,000 Maintenance Manhours (MMHs)**
 - **Equates to an additional AH64 Battalion**
- UH-60 M Model Fleet
 - 9 Parts
 - Readiness +3.4%
 - **Maintenance Burden Reduced by 26,000 MMHs Annually**





CBM Enabled Army Aircraft





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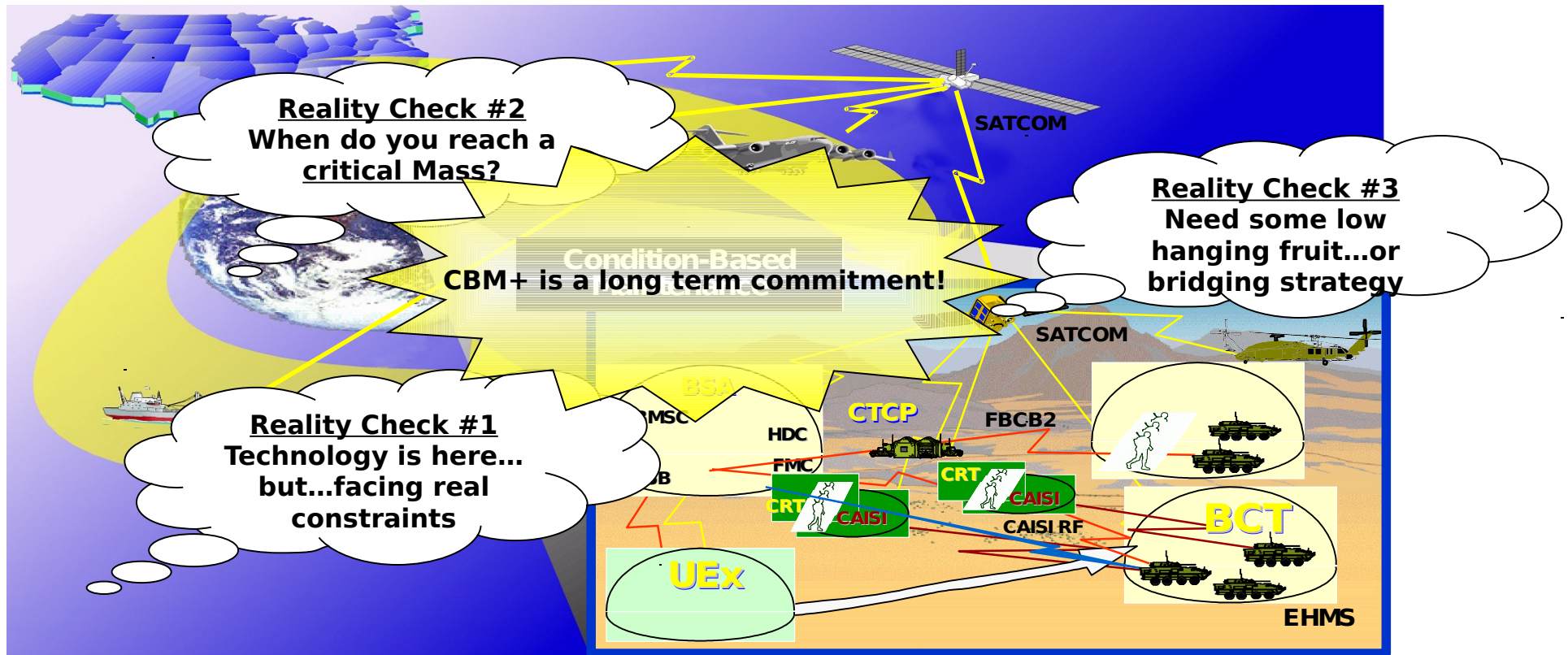
CBM+ Related Efforts

- Defense Advanced Research Projects Agency (DARPA)
- Advanced Concept Technology Demonstrations (ACTD)
- Commercial Technologies for Maintenance Activities (CTMA)
- Joint Oil Analysis Program Technical Service Center (JOAP-TSC)
- Military Flight Operations Quality Assurance (MFOQA)
- Modeling and Simulation
- Industry
- Academia
- Sports and Entertainment
- Corrosion Control
- Allied Military Services





CBM+ Future & Summary



CBM+ is proactive maintenance based on evidence of need performed by maintainers with the right knowledge, tools and support at the optimal time.



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